EXPANSION OF *TUSSILAGO FARFARA* L. IN DISTURBED ENVIRONMENTS.
II. POPULATION REACTION TO SIMULATED CULTIVATION

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ABSTRACT

The effects of systematic cutting, fragmentation and burying on weeded and renewing fallow plots on the density and morphological properties of vegetative and generative *Tussilago farfara* shoots were studied. As the presence of other species increased on fallow plots, the *T. farfara* population regressed. Under such conditions, fragmentation and burying ensured the renewal and expansion of individuals and persistence of the population. On weeded plots, however, additional cultivation reduced the population density and mean values of the analyzed shoot parameters. These results show that systematic cultivation is a prerequisite for persistence of *T. farfara* populations. Its favourable effect is exerted through eliminating potential competitors.

KEY WORDS: weeding, cutting, fragmentation, burying, population renewal, population dynamics, individual morphological properties and biomass.

INTRODUCTION

A characteristic and common feature of disturbed environments is the systematic or random destruction of the plant cover, usually caused by increasing anthropopressure. A classic example of the most highly disturbed environments, created by man and remaining under his strong influence are agrocenoses. Cultivation, especially plowing and harvesting, are drastic disturbances for perennial, polycorm weeds. This type of cultivation causes cutting, pulling, burying or fragmentation of plants.

The varied and complex life strategies of these species basically come down to their ability to renew under conditions of intense agricultural cultivation, moreover, most of them are adapted to permanent occurrence only in environments which are constantly disturbed (Grime 1979, 1987, Duke 1985 and literature cited therein, Harper 1985, Falińska 1991).

Numerous studies, mostly experimental, on the biology and ecology of weeds have shown that the effectiveness of their renewal depends to a large degree on the way the agrocenose is cultivated, and the various procedures used have different effects on the dynamics and morphological traits of the individuals (Jackson 1985, Ernst et al. 1987, McBrien and Harmsen 1987, Briske and Anderson 1990, Hay et al. 1990).

Tussilago farfara is a polycorm weed which infests cultivated fields and is difficult to eradicate. Its frequent domination in plant communities accompanying crop plants and its dramatic recession on fallow fields have already been demonstrated (Namura-Ochalska 1988, 1989). The results presented in this paper show that cultivation has a favourable effect on the growth and development of *T. farfara* individuals, moreover, that it is an essential condition for the population to become established.

The objective of this study was to examine the effects of various agricultural procedures on the population dynamics of renewing *T. farfara* populations and on changes in the morphology of shoots.

The effects of weeding, cutting, burying and fragmentation of *T. farfara* individuals on emergence and size of their vegetative and generative shoots were examined.

METHODS

Experiments aimed at ascertaining the effects of various procedures simulating plowing and harvesting on the regeneration of damaged and emergence of new *T. farfara* shoots were carried out on a farm field in Brzezina Łyńska in the Mazury District.

In 1983, 24 plots were delineated, each with a surface of $0,25m^2$. The plots were separated from each other with plastic foil which prevented rhizomes from "escaping". Five one-month-old individuals were planted on each plot in July. From then on to the end of the vegetation season, all emerging individuals belonging to other species were removed.

Starting from 1984, weeding was stopped on 12 plots. Every month from April to September for three successive years, *T. farfara* shoots were cut and all of the emerged plants were buried and fragmented, both on the weeded and unweeded plots. Each time, then, only *T. farfara* shoots were cut, while the above-ground parts of all of the plants were completely buried and their roots and rhizomes fragmented 30 cm below ground. Each variant was carried out in three replicates. All of the emerging T. *farfara* shoots on each plot were labelled. Twice a year, in April and July, *T. farfara* shoots were counted, their height, leaf stalk length and leaf blade length and width were measured. The length of the vegetative shoots was taken as the length of the longest leaf stalk. The Jentys-Szaferowa (1959) method was used for comparison of the morphology of shoots from weeded and unweeded plots and when additional procedures were or were not used.

In order to determine the effect of the used procedures on the weight of an average shoot, all of the *T. farfara* shoots on all of the plots were cut in September, 1986 and weighed after drying.

RESULTS

CHANGES IN SHOOT DENSITY DUE TO BURYING, CUTTING AND FRAGMENTATION OF INDIVIDUALS.

The experiments showed that *T. farfara* was very resistant to cutting, burying and fragmentation, although the effect of each of these procedures on its population dynamics and count depended to a large degree on the presence or absence of other species.

On the weeded plots, all of the procedures used caused a decline in the density of vegetative and generative shoots, which intensified with time (Table 1).

In the first year the number of vegetative shoots was 1.5 times lower in comparison with control plots (i.e. weeded, with no additional procedures). Over the three year period, these differences increased to over 3.5 times (Fig. 1).

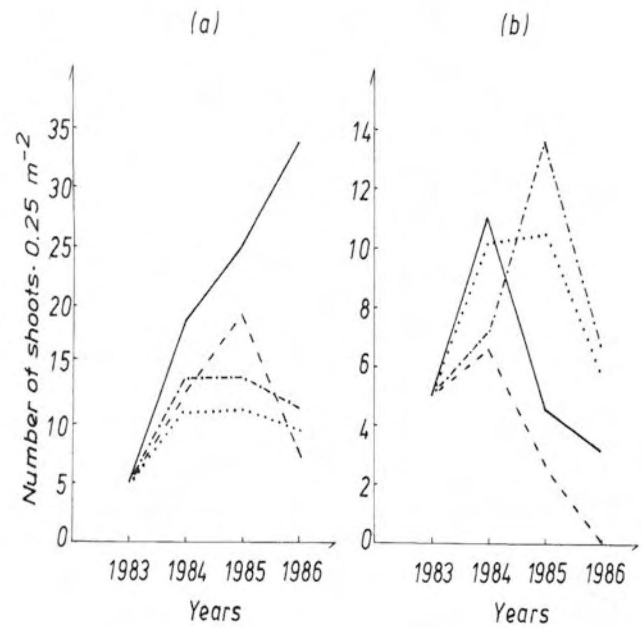

Fig. 1. Changes in population density of vegetative shoots on weeded (a) and unweeded (b) plots with or without additional procedures. Procedures: cutting of *Tussilago farfara* shoots (1), fragmentation of underground parts (2), burying above-ground parts (3), no additional procedures (4).

The type of additional procedure was found not to have a significant effect on the final result of the study: the number of vegetative shoots was similar both when the individuals were cut, buried or fragmented.

Cutting and separating individuals in the generative stage of development caused a 5.5-fold drop in the number of flowering shoots over the three year period (Figure 2). Burying generative shoots had a much less pronounced effect on decreasing their number.

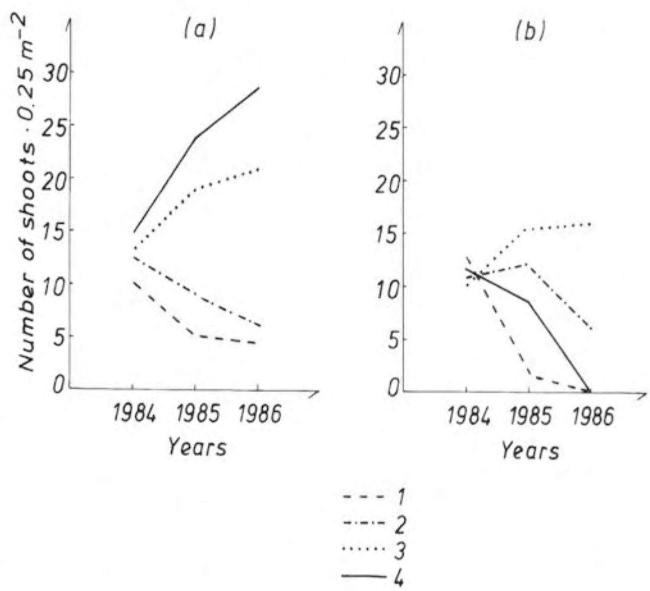

Fig. 2. Changes in population density of generative shoots on weeded (a) and unweeded (b) plots with or without additional procedures. Procedures: cutting of *Tussilago farfara* shoots (1), fragmentation of underground parts (2), burying above-ground parts (3), no additional procedures (4).

On the unweeded plots on which spontaneous renewal of the plant cover was taking place, mainly by grasses, burying and fragmentation of individuals led to an increase in both vegetative and generative shoot density at the end of the study period in comparison with control (no cultivation at all). Monthly cutting of shoots, however, when the plots were being increasingly covered by other species led to the complete elimination of *T. farfara*.

The experiments showed that weeding which was not accompanied by any other procedures had the greatest effect on the dynamics of vegetative and generative shoots. Under these conditions, rapid population growth was observed over the successive years of the study. Over a period of four years the vegetative shoot density increased 10 times over that in the unweeded plots, while of generative shoots, 24 times.

CHANGES IN THE MORPHOLOGICAL STRUCTURE OF SHOOTS AFTER CUTTING, BURYING AND FRAGMENTATION OF INDIVIDUALS

The procedures used in this study which simulated plowing and harvesting, affected not only shoot density but also their morphology (Table 1).

The only exception is the variant where only weeding was carried out; the morphology of the shoots did not change significantly under these conditions.

Cutting, burying and fragmentation of individuals on weeded plots resulted in a decrease in almost all of the measured parameters in comparison with the variant in which only members of other species were removed (Fig. 3a, Table 1).The only exception was the greater number of generative shoots found in clumps and number of leaves on a shoot seen at the end of the experiment.

The use of additional procedures on the unweeded plots had various effects on shoot morphology. Cutting caused a fall in all of the measured parameters, whereas fragmentation and burying of individuals - their abrupt increase (Fig. 3b, Table 1.)

TABLE 1. Density and morphological properties of *Tussilago farfara* shoots in experimental plots

		Weeded plots						Unweeded plots					
		1984		1985		1986		1984		1985		1986	
Treatment	Properties	$\bar{x} \pm s$	V(%)	$\bar{x} \pm s$	V(%)	$\bar{x} \pm s$	V(%)	$\bar{x} \pm s$	V(%)	$\bar{x} \pm s$	V(%)	$\bar{x} \pm s$	V(%)
Control plots	Vegetative shoots density	18.8±2.1	11.3	25.3±4.7	18.7	33.8±4.9	14.6	11.1±2.6	23.7	4.6±2.1	46.1	3.1±2.0	64.7
	Leaf number on the vegetative shoot	2.4±0.3	12.4	2.9±0.3	8.9	2.6±0.2	8.3	2.3±0.4	15.5	2.5±0.7	26.1	1.8±0.5	28.6
	Vegetative shoot height (cm)	12.2±2.5	20.4	14.2±0.9	6.5	14.8±0.9	6.8	23.5±2.7	11.2	21.6±6.0	27.9	6.4±5.4	85.0
	Leaf stalk length (cm)	10.7±2.2	20.9	11.5±1.0	8.9	13.7±1.0	7.0	20.5±2.6	12.8	17.3±3.9	22.7	5.6±4.0	70.6
	Leaf blade length (cm)	7.0±0.8	11.6	7.9±0.2	2.2	7.3±0.3	4.6	7.6±0.9	11.3	7.1±1.3	18.4	3.6±2.1	59.5
	Leaf blade width (cm)	8.1±1.1	13.9	8.9±0.2	2.6	8.7±0.6	6.5	8.8±1.2	13.6	9.1±1.8	19.3	3.6±2.2	61.8
	Generative shoots density	14.7±2.8	18.9	23.8±3.7	15.6	28.3±5.7	20.3	11.7±2.4	20.8	8.5±2.8	32.7	1.2±0.6	54.2
	Generative shoot number in a clump	3.5±0.2	4.8	3.8±0.2	4.9	3.1±0.4	12.1	3.0±0.4	14.6	2.5±0.8	31.7	1.9±0.5	27.1
	Generative shoot height (cm)	10.2±1.5	15.0	12.2±0.2	1.9	17.6±1.5	8.7	14.2±3.1	22.0	20.5±6.4	30.9	15.3±5.1	32.5
Cutting of shoots *Tussilago farfara*	Vegetative shoots density	13.0±3.4	26.4	19.5±2.8	14.5	7.9±1.4	17.2	6.6±2.6	39.5	2.6±1.9	73.1	*Tussilago farfara* not present	
	Leaf number on the vegetative shoot	2.5±0.5	19.1	3.0±0.5	15.3	2.1±0.2	7.3	2.2±0.4	15.9	1.8±0.3	16.5		
	Vegetative shoot height (cm)	10.6±0.5	4.4	8.8±0.5	5.8	5.3±1.5	28.2	11.8±3.1	26.4	8.7±2.7	31.6		
	Leaf stalk length (cm)	8.8±0.6	6.2	6.5±0.6	8.6	3.9±1.1	27.4	10.1±2.7	27.1	7.4±2.3	30.8		
	Leaf blade length (cm)	6.8±0.7	10.3	6.2±0.4	6.3	3.6±0.5	13.8	5..3±1.1	20.5	3.7±0.6	15.4		
	Leaf blade width (cm)	8.1±0.7	8.2	7.1±0.6	8.4	3.6±0.8	20.8	5.9±1.5	24.6	3.9±0.8	20.2		
	Generative shoots density	10.1±2.8	27.2	5.4±1.4	26.4	4.5±1.4	29.9	13.1±3.3	24.9	2.2±0.5	25.1		
	Generative shoot number in a clump	3.9±0.4	10.6	2.0±0.3	13.8	2.3±0.4	15.8	3.2±0.8	25.7	2.2±0.6	30.5		
	Generative shoot height (cm)	12.6±0.9	7.4	9.2±0.8	8.3	8.4±1.5	18.1	10.7±2.6	24.1	18.4±3.6	19.3		
Fragmentation of below-ground parts	Vegetative shoots density	13.9±4.2	29.9	14.1±3.4	23.8	11.5±2.2	19.2	7.1±2.0	28.5	13.8±4.7	33.9	6.6±1.9	29.1
	Leaf number on the vegetative shoot	2.3±0.4	15.5	2.4±0.3	11.2	2.6±0.3	10.2	2.2±0.4	19.8	2.9±0.6	19.6	2.8±0.4	14.9
	Vegetative shoot height (cm)	9.1±0.6	6.2	9.1±1.2	12.6	9.1±0.7	7.8	20.9±1.8	8.6	23.1±3.2	14.1	15.0±3.6	24.3
	Leaf stalk length (cm)	7.8±0.6	7.8	6.6±0.9	14.0	7.6±0.6	7.4	19.2±1.8	9.1	18.2±3.0	16.4	11.3±3.8	33.5
	Leaf blade length (cm)	6.7±0.5	7.0	4.2±0.4	9.0	6.6±0.5	6.8	7.2±1.4	19.0	6.4±1.2	18.5	6.6±0.7	10.2
	Leaf blade width (cm)	7.6±0.6	7.2	4.7±0.5	10.8	7.4±0.7	9.2	8.9±1.5	16.5	7.6±1.3	17.6	7.6±0.8	11.1
	Generative shoots density	12.6±2.3	18.5	9.2±1.8	19.2	5.4±1.3	24.4	11.1±3.2	29.0	12.4±5.0	40.1	6.5±1.4	21.1
	Generative shoot number in a clum	3.4±0.7	21.8	2.3±0.3	13.3	2.7±0.4	16.0	3.5±0.4	10.7	2.8±0.6	22.4	2.2±0.7	29.5
	Generative shoot height (cm)	10.5±0.9	8.7	9.5±0.7	7.7	7.3±0.7	9.3	12.2±1.1	8.7	18.6±4.5	24.1	23.4±7.5	32.2
Burying of above-ground parts	Vegetative shoots density	12.0±1.3	10.9	11.4±1.7	14.8	9.7±1.8	18.4	10.3±2.6	24.9	10.5±1.4	13.5	5.8±1.2	20.3
	Leaf number on the vegetative shoot	2.6±0.2	5.7	3.2±1.0	29.6	2.7±0.2	9.0	2.9±0.6	18.8	2.9±0.4	14.4	2.6±0.2	9.3
	Vegetative shoot height (cm)	10.2±0.6	6.2	11.5±2.4	21.2	9.9±0.9	9.2	16.9±1.8	10.8	20.0±2.3	11.3	18.2±1.3	6.9
	Leaf stalk length (cm)	8.3±0.5	6.3	8.8±1.7	18.9	8.6±0.5	5.8	13.6±1.9	13.7	17.5±1.9	25.0	15.1±1.1	7.6
	Leaf blade length (cm)	6.1±04	6.2	6.1±1.0	16.8	4.4±0.5	11.4	7.2±0.9	12.9	6.1±0.7	10.9	4.7±0.4	9.0
	Leaf blade width (cm)	7.2±0.6	7.2	7.4±1.4	18.8	5.0±0.7	12.9	8.6±1.0	11.8	7.0±0.8	11.8	5.4±0.6	10.3
	Generative shoots sensity	13.0±2.5	19.3	21.1±3.6	17.0	19.0±5.2	27.1	11.0±3.5	32.0	15.3±5.2	34.2	16.2±4.6	28.3
	Generative shoot number in a clum	4.0±0.3	8.3	4.1±0.8	20.5	4.3±0.4	8.1	2.8±0.7	24.7	3.0±0.7	22.2	2.8±0.6	22.3
	Generative shoot height (cm)	9.8±0.8	7.8	10.6±2.1	20.0	9.9±0.9	9.4	12.6±2.4	19.0	20.8±2.8	13.6	18.5±3.0	16.1

Explanations: $\bar{x}$ - mean value, s - standard deviation, V - coefficient of variation

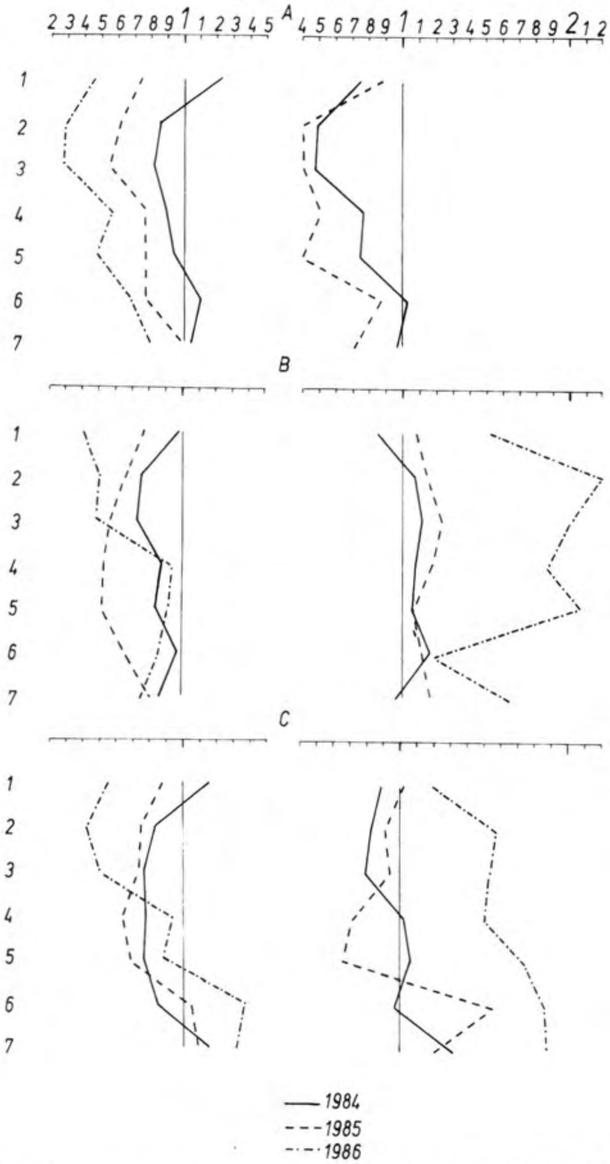

Fig. 3. Comparison of morphological traits of shoots from weeded (a) and unweeded plots (b) by the Jentys-Szaferowa method (1959) with (broken lines) or without (vertical line) additional procedures. Procedures: cutting of *Tussilago farfara* shoots (A), fragmentation of underground parts (B), burying above-ground parts (C). Traits: height of generative shoot (1), height of vegetative shoot (2), length of leaf stalk (3), length of leaf blade (4), width of leaf blade (5), number of generative shoots in clumps (6), number of leaves per vegetative shoot (7).

The greatest effect on shoot size and morphology was exerted by the increasing proportion of grass species when no additional procedures were used. (Fig.4, Table 1). As early as in the first year of the study a dramatic increase in shoot length was found on the plots of which the cover was undergoing renewal, in comparison with the shoots on the weeded plots, but a dramatic fall in this parameter was seen at the end of the study. (Fig. 4, Table 1). After 3 years of spontaneous covering of the plots by grasses, the remaining parameters of the shoots also decreased significantly.

THE EFFECT OF CUTTING, BURYING OR FRAGMENTATION OF INDIVIDUALS ON THE BIOMASS OF VEGETATIVE SHOOTS.

The experiments showed that the used procedures had a significant effect on the biomass of *T. farfara* shoots (Fig. 5). The greatest mass of an average shoot was found in the ex-

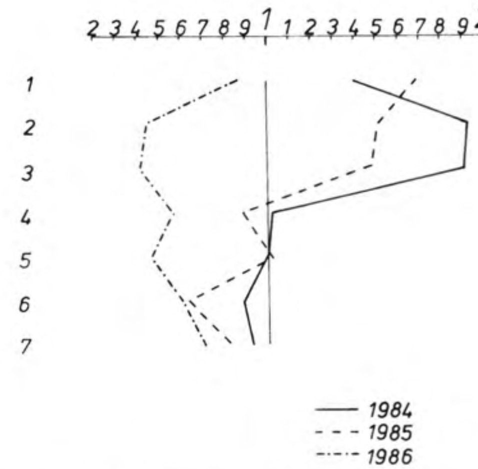

Fig. 4. Comparison of morphological traits of shoots from unweeded (broken lines) and weeded plots (vertical line) by the Jentys-Szaferowa method (1959). Traits: height of generative shoot (1), height of vegetative shoot (2), length of leaf stalk (3), length of leaf blade (4), width of leaf blade (5), number of generative shoots in clumps (6), number of leaves per vegetative shoot (7).

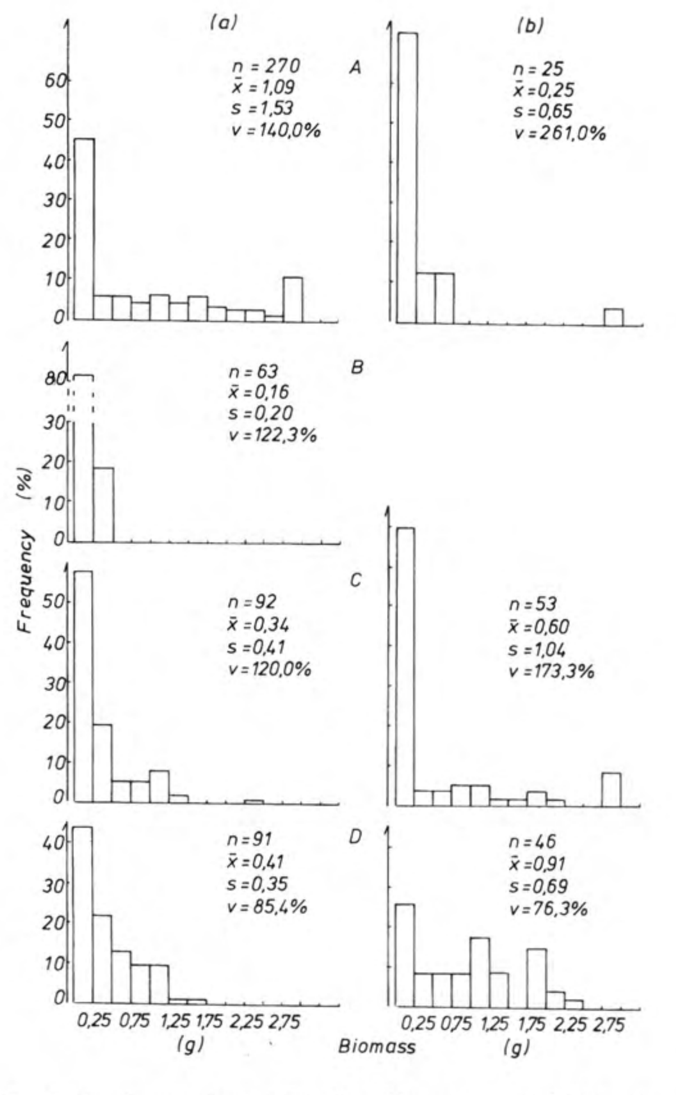

Fig. 5. Distribution of vegetative shoot biomass on weeded (a) and unweeded (b) plots with (A) or without additional procedures. Procedures: cutting *Tussilago farfara* shoots (B), fragmentation of underground parts (C), burying above-ground parts (D).

perimental variant in which other species were removed and no other procedures used. It was four times greater than the biomass of shoots growing on unweeded plots where no other procedures were carried out (Fig. 5a). Monthly cutting, burying or fragmentation of individuals on weeded plots always caused, regardless of the type of disturbance, a several-fold drop in shoot biomass (Fig. 5a). The smallest biomass value was characteristic, which is obvious, for the shoots which were subject to regular cutting.

The fall in shoot biomass was accompanied by significant equalization of its value; the shoots became very similar to each other in terms of weight.

Burying and fragmentation of individuals on unweeded plots were the reason for increasing average shoot biomass and increased variation of dry mass of individual shoots (Fig. 5b).

DISCUSSION

The results obtained on experimental plots on which plowing and harvesting were simulated and on which other species were absent or present, confirm the statement that *T. farfara* tolerates environmental disturbances caused by agricultural procedures very well.

The adaptation of *T. farfara* to growth and development under conditions of intensive agricultural cultivation stems from its developmental biology where the most important role is played by its clonal form of growth. This has been shown by many authors for other polycorm species as well (Maun 1984, 1985, Schmid and Harper 1985, Cornelius and Faensen-Thiebes 1990, Pyke 1990, Schmid et al. 1990).

In spite of *T. farfara's* ability to undergo two, extremely different types of clonal growth, phalanx growth which leads to the formation of clumps of generative shoots and querilla growth which guarantees the development of separated vegetative shoots, the latter is decisive in population renewal after cutting, fragmentation or burying of individuals. This is seen by the fact that none of the procedures used in this study, with the exception of cutting *T. farfara* shoots under conditions of increasing sodding, inhibited querilla type growth. Many studies on the biology and ecology of clonal species have demonstrated that this type of growth leads to extremely rapid proliferation of under-, and above-ground shoots, thus the quick expansion of individuals after the disturbance is past (Cook 1985, Duke 1985 and literature cited therein, Sebens and Thorne 1985, Falińska 1991, Jónsdóttir 1991).

The high effectiveness of emergence of new shoots after disintegration of *T. farfara* polycorms explains the resistance of this species to mechanical injury of underground organs during plowing.

It should be emphasized that on the weeded plots, on which additional procedures causing the elimination of the above-ground parts of plants were used, regeneration of injured shoots was noticed in addition to the emergence of new shoots. Cutting of vegetative shoots, which in *T. farfara* are short shoots, was in practice defoliation and did not suppress the appearance of new leaves. The experiment showed, however, that frequent and systematic defoliation does cause a decline in regenerative potential of *T. farfara*, which in association with depletion of nutrients stored in the rhizomes, leads to the death of the individual. Therefore, as has been shown in studies on other species, intense grazing leads to a decline in the number of individuals and their size, which causes regression of the population (Jackson 1980, Mc Brien and Harmsen 1987, Olson and Richards 1989, Davies and Evans 1990).

Burying of vegetative shoots stimulated their vertical growth, which leads to the appearance of new leaves above the ground. The appearance of new shoots is possible, though difficult, after burying. The presence of *T. farfara* on landslides and eroded slopes becomes therefore understandable, since the burying of the above-ground parts of plants is a common occurrence.

In distinction from vegetative shoots, the emergence of generative shoots in the spring is totally dependent on the development of their buds in the autumn during the previous growth season. The cutting of inflorescences that occurs in the agrocenose during spring plowing arrests their further development and the production of seeds. Studies have shown, however, that the functions of at least some of the cut generative shoots are taken over by shoots that had been delayed in their development to that point and, at the time of the disturbance had been situated below or, at most, just at the ground surface. The presence of undeveloped shoots has been found, especially when the population is dense. Their low height protects them from being cut and their intense development occurs after the disturbance has passed.

Burying of generative shoots without destroying the inflorescences stimulates internode elongation and ensures their re-emergence above ground. During burying the inflorescences were, however, frequently broken, which was the major reason for the decline in their number. Measurements of their size were not always in agreement with the elongation of generative shoots since this measurement always applied to only their above-ground part.

The arguments presented above show that the manner and effectiveness of *T. farfara* individual and population renewal in an agrocenose depends to a large degree not only on the type of cultivation procedures used, but also on their frequency and timing, similarly as in the case of other polycorm weeds (Garnier and Roy 1988, Olson and Richards 1988, 1989, Briske and Anderson 1990, Davies and Evans 1990).

It should be emphasized, however, that on the weeded plots, all of the additional procedures always caused a decrease in the number of both vegetative and generative shoots. Along with the fall in density, the height of both types of shoots also decreased as did leaf size.

On the other hand, on the plots on which all of the species other than *T. farfara* were removed, the *T. farfara* cover reached 100% over the three-year period of study (more than 33 shoots emerged on plots with surfaces of $0{,}25m^2$).

Interesting results were also obtained by comparison of the effects simulating plowing and harvesting on the unweeded plots with those where these procedures were not used. When there were no external disturbances, a dramatic increase in the population of grass species occurred, accompanied by an equally dramatic decline in *T. farfara* shoot density. Similar results indicating that *T. farfara* is a weak competitor were obtained on a neighboring fallow field and the reason for arrest of vegetative growth and recession of the population were discussed in previous papers (Namura-Ochalska 1988, 1989).

These experiments have, in addition, shown that under conditions of increasing sodding, regression of *T. farfara* populations is notably accelerated by cutting its shoots, which leads to a steady decline in its photosynthesizing surface.

Burying of the plants and fragmenting their rhizomes and roots carried out on unweeded plots limited the development of grasses which, in turn, increased the chances for renewal of *T. farfara* individuals. both by regeneration of injured shoots and emergence of new ones.

In summary, it can be stated that *T. farfara* is characterized by a series of adaptations thanks to which it functions very well on regularly cultivated fields. Its ability for rapid renewal and development of individuals due to regeneration of injured shoots and emergence of new ones permits expansion of *T. farfara* populations in disturbed environments, even when these disturbances occur with high intensity and frequency. Studies have shown, however, that the favourable effects of procedures simulating plowing and harvesting are based mainly on the elimination of potential competitors, thus act indirectly.

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EKSPANSJA PODBIAŁU POSPOLITEGO *TUSSILAGO FARFARA* L. W ŚRODOWISKACH ZABURZONYCH. II. ODNAWIANIE SIĘ POPULACJI W WARUNKACH SEZONOWYCH ZABURZEŃ

STRESZCZENIE

Celem pracy było zbadanie wpływu zabiegów rolniczych na odnawianie się populacji. Zakres pracy obejmował ustalenie wpływu ścinania, fragmentacji, i zasypywania osobników na pojaw i wielkość wegetatywnych i generatywnych pędów na poletkach pielonych i nie pielonych.

Stosowanie zabiegów symulujących orkę i żniwa wskazuje na dużą odporność *T. farfara* na ścinanie, zasypywanie i fragmentację osobników, przy czym wpływ każdego z tych zabiegow na dynamikę liczebności i pokrój pędów zależy od obecności i udziału innych gatunków. Wyniki doświadczeń wykazały, że: 1) ścinanie, fragmentacja i zasypywanie osobników przy braku konkurencji międzygatunkowej spowodowały spadek zagęszczenia wegetatywnych i generatywnych pędów; 2) fragmentacja i zasypywanie przy wzrastającym udziale innych gatunkow są przyczyną wzrostu zagęszczenia obu typów pędow; 3) na poletkach pozostawionych odłogiem nastepuje proces wycofywania się populacji, przyspieszony w warunkach dodatkowego ścinania pędów podbiału; 4) wszystkie dodatkowe zabiegi na poletkach pielonych spowodowały spadek wartości większości analizowanych cech pędów; 5) fragmentacja i zasypywanie na poletkach nie pielonych były przyczyną wzrostu wartości wszystkich morfologicznych cech pędów w ostatnim roku badań; 6) dopiero silny wzrost zadarnienia i zacienienia na poletkach pozostawionych odłogiem w porównaniu z pielonymi był przyczyną spadku wysokości wegetatywnych i generatywnych pędów oraz wielkości liści; 7) największe różnice w zagęszczeniu, pokroju i biomasie pędów wystąpiły między osobnikami rosnącymi na poletkach pielonych i nie pielonych, przy braku dodatkowych zabiegów. Co więcej porównanie uzyskanych wyników prowadzi do wniosku, że zabiegi rolnicze są niezbędnym warunkiem trwałości populacji *T. farfara.* Korzystny wpływ systematycznych zaburzeń polega na redukcji potencjalnych konkurentow. Należy podkreślić, że szczególnie wysokie zdolności odnawiania i rozrastania mają osobniki będące w fazie wegetatywnej.

SŁOWA KLUCZOWE: pielenie, ścinanie, fragmentacja, zasypywanie, odnowa populacji, dynamika populacji, osobnicze właściwości morfologiczne i biomasa